DOI: 10.7860/IJARS/2023/64554.2921

Original Article

Surgery Section

Evaluation of the Effectiveness of Percutaneous Nephrolithotomy in Supine and Prone Positions: A Prospective Interventional Study from Telangana, India

J SASI KUMAR[1], Y ANIL REDDY[2], N RAMAMURTHY[3], SAGAR MAHAVIR SOITKAR[4], CH VAMSEEDHAR REDDY[5], RAHUL SHARMA[6], NISHANTH MYDAM[7], JAGDISHWAR ADDEPALLI[8]

ABSTRACT

Introduction: Percutaneous Nephrolithotomy (PCNL) is the preferred method for treating large or complex renal calculi. Despite positive results and apparent benefits over the prone position, there are few randomised trials comparing the supine and prone positions.

Aim: To evaluate the effectiveness of PCNL in prone and supine positions in terms of operative time, stone-free rate, hospital stay, postoperative complications, and the level of haemoglobin drop.

Materials and Methods: The study was conducted from December 2020 to December 2022, at the Department of Urology, Mamata Medical College in Khammam, Telangana, India. Patients with renal stones diagnosed by Non-Contrast Computed Tomography (NCCT) Kidney Ureter Bladder (KUB) and meeting the inclusion criteria were enrolled. Patient demographic data, operative time, stone-free rate, haemoglobin level drop, postoperative fever, and hospital stay in prone and supine positions were recorded. Statistical tests like chi-square or Fisher-exact test were used to compare proportions, and the student t-test was used to compare means.

Results: The overall operative time was 79.50 minutes in the prone group and 66.78 minutes in the supine group (p=0.0213). The average hospital stay was 2.68 days in the prone group and 2.72 days in the supine group (p=0.2432). Fall in haemoglobin levels, size of stones extracted, and stone-free rate at three months between the two groups (p>0.05) showed insignificant relation. Furthermore, there was no significant difference in complications between the two groups (p>0.05).

Conclusion: PCNL performed with the patient in the supine position requires significantly less time during surgery. There was no significant difference in terms of stone-free rate, hospital stay, fall in haemoglobin levels, and complications between the supine and prone groups.

Keywords: Complications, Length of Stay, Non-contrast computed tomography, Treatment outcome

INTRODUCTION

It is generally agreed upon that PCNL is the preferred method for treating large or complex renal calculi [1]. Since its inception in 1976, the surgical technique and endoscopic tools have undergone continuous development, leading to improved success rates and reduced complications and morbidity [2]. However, the procedure has faced challenges, and new methods are constantly being developed.

Most of the time, PCNL is carried out through a puncture performed with the patient in the prone position, accessing the posterior calyx. This method is well-established, highly effective, and associated with minimal complications. In contrast, the supine position for PCNL, first described by Valdivia-Uria in 1998, is less commonly used, but it offers potential benefits such as simultaneous PCNL and ureteroscopic procedures, improved airway control, and efficient stone particle evacuation through Amplatz sheath drainage [3]. On the other hand, the prone position has drawbacks related to anaesthesia, logistics, and surgical considerations [4]. Despite these potential advantages of the supine position, its adoption in urologic practice has been limited, possibly due to lack of experience and concerns about colonic injuries.

There have been few randomised trials directly comparing the supine and prone positions, despite the positive results and apparent benefits of the supine position over the prone position [5-9]. Given that supine PCNL has only been practiced for around ten years compared to prone PCNL's 25 years, it is understandable that urologists may still favor the prone position. However, a larger series of randomised studies is needed to evaluate the two approaches and determine the most suitable access technique for each patient.

Despite the significant number of PCNL procedures performed in our country, there is a lack of published systematic research comparing the supine and prone positions. Therefore, our study aims to evaluate the effectiveness and safety of PCNL in both the traditional prone and supine positions.

MATERIALS AND METHODS

This prospective interventional study was conducted at the Department of Urology, Mamata Medical College in Khammam, Telangana, from December 2020 to December 2022, after obtaining approval from the Institutional Review Board (IRB/91/20). All patients included in the study provided informed consent.

Inclusion criteria: patients greater than 18 years of age, with renal stones diagnosed by Non-Contrast Computed Tomography (NCCT) Kidney Ureter Bladder (KUB) were included in the study.

Exclusion criteria: Patients younger than 18 years old, those with active urinary tract infections, those undergoing simultaneous bilateral procedures, those with a second-stage PCNL and a PCN tube in place, and those who failed to report with X-ray KUB and ultrasonography (USG) after a month were excluded from the study

The allocation of patients to the two groups (supine and prone) was done randomly using purposive convenience sampling. The supine group consisted of 32 patients, and the prone group consisted of 18 patients.

Procedure

Stone burden in both groups was determined by calculating the stone volume (Length × Width × Height) using NCCT KUB. PCNL procedures were performed by consultant urologists using the recommended method. Patients received a prophylactic antibiotic intravenously 30 minutes before anaesthesia, based on urine culture and sensitivity report. The procedures were performed under general anaesthesia in both the prone and supine positions.

After general anaesthesia, the patient was positioned in the lithotomy position. A cystoscopy was performed in both groups to implant a 6 Fr straight-tip open-end ureteral catheter in the ipsilateral pelvi-calyceal system under fluoroscopic guidance. In the supine group, a Valdivia supine position was used, with a bolster placed beneath the ipsilateral side hips and shoulders to raise the flank from the operating table at a 20-degree angle. In both groups, a retrograde pyelogram was performed.

A Terumo 0.035" guidewire was inserted after an 18-gauge IP needle penetrated the target calyx under fluoroscopic supervision. The number of punctures performed depended on the size and location of the calculus. Serial PTFE screw dilators were used for dilatation, and a Shah sheath (15 or 21F) with a suction apparatus was used. A Richard Wolf 12F French rigid nephroscope was used for nephroscopy. Stones were located and fragmented using a pneumatic lithotripter or Ho-YAG Laser. Forceps were used to remove small stones, and a suction pump was used for stone extraction. The decision for tubeless, total tubeless, or standard drainage options was based on the length of the procedure and the surgeon's preference [Table/Fig-1,2].

[Table/Fig-1]: Supine position of performing Percutaneous Nephrolithotomy (PCNL).

[Table/Fig-2]: Prone position of performing Percutaneous Nephrolithotomy (PCNL).

The operation time, from ureteral catheterization through egress, was recorded. Nephrostomy tubes, if placed, were removed on the first postoperative day, and Foley catheters were removed on the second postoperative day. Patients were discharged on the same day as the Foley removal if they were comfortable, afebrile, and had a dry nephrostomy site. JJ stents were removed after two weeks.

A stone-free state was defined as having no residual stones on X-ray KUB and USG of KUB at the one-month follow-up. Patient demographic data, operative time, stone-free rate, haemoglobin level drop, postoperative complications, and hospital stay were compared between the prone and supine positions. Postoperative complications were classified using the Clavien-Dindo classification [10].

STATISTICAL ANALYSIS

The data was collected, compiled, and analysed using EPI info (version 7.2). Categorical variables were expressed in terms of percentages, while continuous variables were presented as Mean and SD (standard deviation). The difference between the two proportions for categorical variables was analysed using the chi-square test, while the difference between continuous variables was assessed using the student t-test. All analyses were two-tailed, and the significance level was set at 0.05.

RESULTS

The mean age of the cases in both groups was comparable, with 43.21 years in the Supine group and 42.34 years in the Prone group. Other variables such as body mass index, laterality, and gender were also comparable between the two groups ($p>0.05$) [Table/Fig-3].

The overall operative time was 79.50 minutes in the Prone group and 66.78 minutes in the Supine group ($p=0.0213$). The average hospital stay was 2.68 days in the Prone group compared to 2.72 days in the Supine group ($p=0.2432$). There was no significant difference in the fall in haemoglobin levels, size of stones extracted, and stone-free rate at one month between the two groups ($p<0.05$) [Table/Fig-4].

Based on the Clavien-Dindo classification, in the Supine position, there were two cases each of Grade-I and II complications. In the Prone position, one case of Grade-I and two cases of Grade-II complications were reported. There was no significant difference in complications between the two groups ($p>0.05$) [Table/Fig-5].

DISCUSSION

Most surgeons prefer PCNL as the method of choice for large renal stones, but the positioning of the patient during the procedure remains a topic of debate.

In our study, the operative time was significantly longer in the prone position compared to the supine position ($p<0.05$). Similar findings were reported by Zhan H et al., Al-Dessoukey AA et al., Aai AMA, and Abdel-Mohsen E et al., [7,8,11,12]. However, studies conducted by Basiri A et al., Keshavmurthy M et al., and Choudhury S et al., contradicted findings of the present study [Table/Fig-6] [6-8,11-15].

Demographic particulars	Supine position (n=32)		Prone position (n=18)		p-value
	Mean	SD	Mean	SD	
Age (years)	43.21	3.44	42.34	2.89	0.6723*
Body mass index (kg/m^2)	21.34	2.17	23.40	3.56	0.3451*
Laterality (Right/Left)	14/18	43.75%/56.25%	8/10	44.44%/55.56%	0.6652**
Gender (Male/Female)	19/13	59.37%/40.63%	12/6	66.67%/33.33%	0.3421**

[Table/Fig-3]: Demographic particulars of the sample.
*Student t-test
**Chi-square test

Secondary outcomes	Supine position (n=32)		Prone position (n=18)		p-value
	Mean	SD	Mean	SD	
Operative time (minutes)	66.78	12.12	79.50	11.13	**0.0213***
Hospital stay (days)	2.72	0.73	2.68	0.87	0.2432*
Fall in haemoglobin (%)	0.73	0.40	0.53	0.34	0.0851*
Size of stones (mm)	2.15	0.78	2.41	0.78	0.2658*
Stone free rateafter 1 month	30/32=93.75%		17/18=94.45		0.8347**

[Table/Fig-4]: Outcomes of the study participants.
*Student t-test
**Chi-square test

Clavien dindo classification [10]	Supine position (n=32)		Prone position (n=18)		p-value
	Number	%	Number	%	
Grade-I	2	6.25	1	5.56	0.8277
Grade-II	2	6.25	2	11.1	0.5622

[Table/Fig-5]: Complications based on clavien dindo classification among both the groups.
Chi-square test

Operative time (minutes)	Supine position		Prone position	
	Mean	SD	Mean	SD
Present study (India)	66.78	12.12	79.50	11.13
Aai AMA, [11] (China)	55.43	22.50	76.80	16.6
Abdel-Mohsen E et al., [12] (Saudi Arabia)	88	16	104	25
Basiri A et al., [13] (Saudi Arbia)	110.20	45	111.2	39,4
Al-Dessoukey AA et al., [8] (Italy)	86.16	33.70	111.7	39.40
Wang Y et al., [6] (Korea)	88	31.25	78	26.25
Zhan H et al., [7] (China)	56	15	86	23
Keshavmurthy M et al., [14] (India)	101.74	54.38	102	35.10
Choudhury S et al., [15] (India)	91.76	8.72	85.43	8.12

[Table/Fig-6]: Comparison of the operative time with other studies [6-8,11-15].

Regarding hospital stay, the authors did not find any significant difference between the average stay in both groups (p>0.05). Similar conclusions were reported by Mehrabi S et al., Wang Y et al., Al-Dessoukey AA et al., Aai AMA, Basiri A et al., Keshavamurthy M et al., and Choudhury S et al., [Table/Fig-7] [5-8,11,13-15].

Hospital stay (days)	Supine position		Prone position	
	Mean	SD	Mean	SD
Present study (India)	2.72	0.73	2.68	0.87
Aai AMA, [11] (China)	3.33	2.12	3.87	2.77
Al-Dessoukey AA et al., [8] (Italy)	2.08	0.82	3.38	1.46
Basiri A et al., [13] (Saudi Arabia)	2.48	0.75	2.95	1.50
Mehrabi S et al., [5] (Iran)	2.44	1.02	2.32	0.56
Wang Y et al., [6] (Korea)	8.4	1.5	8.2	1.25
Zhan H et al., [7] (China)	6	1.1	6	1.5
Keshavamurthy M et al., [14] (India)	2.76	0.78	2.64	0.67
Choudhury S et al., [15] (India)	4.10	1.12	3.86	0.98

[Table/Fig-7]: Comparison of the hospital stay with other studies [5-8,11,13-15].

In terms of other parameters such as the drop in haemoglobin levels, stone size after extraction, stone-free rate at one month, and postoperative complications, including postoperative fever, there was no significant difference between the two groups in the present study. Neto EAC et al., recently presented their experience with 88 PNL procedures in the supine position [16]. Their study included individuals with large or complicated staghorn stones in any location in the kidney, and the supine position with specific leg positioning and cushion placement was found to be effective for the procedure.

According to Chapagain A et al., the percentage of patients without stones at one month was similar in Group-1 (92.1%) and Group-2 (93.02%), with no significant difference (p=0.16) [17]. The overall complication rates in both groups were comparable, with 15.7% in Group-1 and 16.2% in Group-2. No patients in either group experienced complications higher than Clavien IIIa. In a meta-analysis and review of randomised controlled trials, Li J et al. found that the supine group had a significantly lower risk of developing fever (RR 0.67, 95% CI 0.46 to 0.97, p=0.03), and there were no significant differences in rates of urinary leakage, pleural effusion, or blood transfusion between the two groups [18].

Manohar T et al. discussed their experience treating 62 patients with supine PNL. They reported an average drop in haemoglobin of 1.62±1.03 gm/dL, with only 3% of patients requiring blood transfusion. Visceral injury was not observed, and 95% of patients achieved stone clearance with the initial PCNL procedure, with or without ureteroscopy [19]. However, these findings differ from the present study. Neto EAC et al. also performed PNL in the supine position, using ultrasound guidance for caliceal entry and achieving a stone-free rate of 95%. They observed rates of infection (3.2%), visceral injury (18%), blood transfusion (0%), and technical issues (2%) [16]. They noted that accessing higher pole stones sometimes required flexible nephroscopy. Additionally, challenges associated with prone positioning in morbidly obese patients led them to advocate for the supine position.

Manohar T et al. utilised sonography for puncture guidance and created a safe window to protect internal organs from damage [19]. In contrast, Neto EAC et al. demonstrated that puncture over the posterior axillary line without sonography was safe, even with supracostal puncture [16]. They found no differences in stone removal rates between patients with direct access to upper pole stones and those without. However, the present study is significant due to its prospectively collected data, groups with comparable demographics and stone characteristics, routine use of preoperative CT, and experienced surgeons.

Limitation(s)

The small sample size, unequal allocation of patients between the two groups, and the involvement of multiple surgeons in performing the surgeries. These factors may impact the generalisability and reliability of the present findings.

CONCLUSION(S)

In conclusion, the PCNL procedure performed with the patient lying on their back in a supine position offers several advantages over the prone position. One notable benefit is the increased efficiency and reduced duration of the surgery. Interestingly, despite the difference in patient positioning, the present study found comparable outcomes between the supine and prone positions in terms of stone removal success, length of hospitalisation, blood loss (measured by a decrease in haemoglobin levels), and complications. These findings suggest that the choice of patient positioning during PCNL can significantly impact surgical efficiency while maintaining comparable clinical outcomes in terms of stone removal and patient safety.

REFERENCES

[1] Preminger GM, Assimos DG, Lingeman JE, Nakada SY, Pearle MS, Wolf JSJ. Chapter 1: AUA guideline on management of staghorn calculi: diagnosis and treatment recommendations. J Urol. 2005;173(6):1991-2000.

[2] Fernström I, Johansson B. Percutaneous pyelolithotomy. A new extraction technique. Scand J Urol Nephrol. 1976;10(3):257-59.

[3] Valdivia Uría JG, Valle Gerhold J, López López JA, Villarroya Rodriguez S, Ambroj Navarro C, Ramirez Fabián M, et al. Technique and complications of percutaneous nephroscopy: experience with 557 patients in the supine position. J Urol. 1998;160(6 Pt 1):1975-78.

[4] El-Nahas AR, Shokeir AA, El-Assmy AM, Mohsen T, Shoma AM, Eraky I, et al. Post-percutaneous nephrolithotomy extensive hemorrhage: a study of risk factors. J Urol. 2007;177(2):576-79.

[5] Mehrabi S, Manzouri L, Ganji R, Mehrabi F. Comparison the success and complications of tubeless percutaneous nephro-lithotomyin prone and supine position under spinal anaesthesia. Acta Medica Cordoba. 2016;5(32):2079.

[6] Wang Y, Wang Y, Yao Y, Xu N, Zhang H, Chen Q, et al. Prone versus modified supine position in percutaneous nephrolithotomy: A prospective randomized study. Int J Med Sci. 2013;10(11):1518-23.

[7] Zhan H, Li Z, Zhou X, Yang F, Huang J, Lu M. Supine lithotomy versus prone position in minimally invasive percutaneous nephrolithotomy for upper urinary tract calculi. Urol Int. 2013;91(3):320-25.

[8] Al-Dessoukey AA, Moussa AS, Abdelbary AM, Zayed A, Abdallah R, Elderwy AA, et al. Percutaneous nephrolithotomy in the oblique supine lithotomy position and prone position: a comparative study. J Endourol. 2014;28(9):1058-63.

[9] Giusti G, De Lisa A. PCNL in the prone position vs PCNL in the modified supine Double-S position: Is there a better position? A prospective randomized trial. Urolithiasis. 2020;48(1):63-69.

[10] Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, et al. The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg. 2009;250(2):187-96.

[11] Aal AMA. Supine percutaneous nephrolithotomy in comparison with the prone standard technique. Zagazig Univ Med J. 2015;19(2):122-27.

[12] Abdel-Mohsen E, Kamel M, Zayed A-L, Salem EA, Ebrahim E, Wahab KA, et al. Free-flank modified supine vs. prone position in percutaneous nephrolithotomy: A prospective randomised trial. Arab J Urol. 2013;11(1):74-78.

[13] Basiri A, Mohammadi Sichani M, Hosseini SR, Moradi Vadjargah A, Shakhssalim N, Kashi AH, et al. X-ray-free percutaneous nephrolithotomy in supine position with ultrasound guidance. World J Urol. 2010;28(2):239-44.

[14] Keshavamurthy M, Pathak N, Rao K, Harinatha S, Tabrez S, Krishnappa P, et al. Supine versus prone percutaneous nephrolithotomy-a randomised comparative study. Int J Clin Urol. 2021;5(1):51.

[15] Choudhury S, Talukdar P, Mandal TK, Majhi TK. Supine versus prone PCNL in lower calyceal stone: Comparative study in a tertiary care center. Urol J. 2020;88(2):148-52.

[16] Neto EAC, Mitre AI, Gomes CM, Arap MA, Srougi M. Percutaneous nephrolithotripsy with the patient in a modified supine position. J Urol. 2007;178(1):165-68.

[17] Chapagain A, Basnet RB, Shah C, Shah AK, Shrestha PM, Shrestha A. Comparative study of percutaneous nephrolithotomy in supine and prone positions. J Nepal Health Res Counc. 2021;19(1):154-57.

[18] Li J, Gao L, Li Q, Zhang Y, Jiang Q. Supine versus prone position for percutaneous nephrolithotripsy: A meta-analysis of randomized controlled trials. Int J Surg. 2019;66:62-71. Doi: 10.1016/j.ijsu.2019.04.016. Epub 2019 Apr 26.

[19] Manohar T, Jain P, Desai M. Supine percutaneous nephrolithotomy: Effective approach to high-risk and morbidly obese patients. J Endourol. 2007;21(1):44-49.

PARTICULARS OF CONTRIBUTORS:

1. Professor and Head, Department of Uro Surgery, Mamata Medical College, Khammam, Telangana, India.
2. Assistant Professor, Department of Uro Surgery, Mamata Medical College, Khammam, Telangana, India.
3. Professor, Department of Uro Surgery, Mamata Medical College, Khammam, Telangana, India.
4. Senior Resident, Department of Uro Surgery, Mamata Medical College, Khammam, Telangana, India.
5. Senior Resident, Department of Uro Surgery, Mamata Medical College, Khammam, Telangana, India.
6. Senior Resident, Department of Uro Surgery, Mamata Medical College, Khammam, Telangana, India.
7. Senior Resident, Department of Uro Surgery, Mamata Medical College, Khammam, Telangana, India.
8. Senior Resident, Department of Uro Surgery, Mamata Medical College, Khammam, Telangana, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Sagar Mahavir Soitkar,
4-2-161, Police Housing Colony, Opp.:, Mamata Medical College Rd, Netaji Nagar, Rotary Nagar, Khammam, Telangana 507002, Khammam, Telangana, India.
E-mail: sagarsoikar@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Apr 17, 2023
- Manual Googling: Jul 04, 2023
- iThenticate Software: Jul 07, 2023 (12%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval Obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Apr 10, 2023**
Date of Peer Review: **Jun 04, 2023**
Date of Acceptance: **Jul 10, 2023**
Date of Publishing: **Sep 01, 2023**